647510 **BSc5PhyC501x** **Seat No :________**

B.Sc. Semester - 5 (*CBCS*) Examination

December -2020 (NEW COURSE)

Mathematical Physics, Classical Mechanics & quantum Mechanics(Core)

Time: 1:30 Hours **Marks: 42**

Instructions:

1. Figures to the right indicate marks.
2. There are five questions in the question paper.
3. Answer any three of the following questions.

1(a) Answer the following questions (any two). **(10)**

(1) Explain in detail : Gradient of a function .
Discuss the geometrical interpretation of the Gradient .

(2) Explain in detail : The Divergence of a vector .
Give its geometrical interpretation .

(3) *Write short note on : The fundamental theorem for Curls* .

1(b) Answer the following question (any one). **(4)**

(1) Write six product rules for extra ordinary derivatives .

(2) Find the gradient of $\mathbf{r} = (x^2 + y^2 + z^2)^{1/2}$

2(a) Answer the following question (any two). **(10)**

(1) Obtain Fourier series for a full-wave rectifier function .

(2) State and prove Parseval's theorem in the form of Fourier coefficients $\mathbf{a_0}$, $\mathbf{a_n}$ and $\mathbf{b_n}$.

(3) Evaluate the Fourier coefficients $\mathbf{a_0}$, $\mathbf{a_n}$ and $\mathbf{b_n}$ of Fourier series .

2(b) Answer the following question (any one). **(4)**

(1) Write the expression of Fourier integral for a given function f(x) .
Obtain the expressions for Fourier sine and cosine transforms .

(2) Define : (i) Dirac-delta function in one dimension .
(ii) Even and Odd functions ,with suitable examples .

3(a) Answer the following question (any two). **(10)**

(1) Obtain Hamilton's equations of motion. Discuss the physical significance of Hamiltonian H .

(2) State Hamilton's variational principle. Obtain Lagrange's equations of motion from Hamilton's principle.

(3) Define: Cyclic co-ordinate.
Show that "Generalized momentum corresponding to a cyclic co-ordinate is conserved" during the motion of a system.
Explain the connection between conservation of momentum and the symmetry possessed by a system.

3(b) Answer the following question (any one). **(4)**

(1) Obtain equation of motion for Atwood's machine , using Lagrange's equation of motion .

(2) Apply Hamilton's equation of motion to obtain equation of motion of compound pendulum .

4(a) Answer the following question (any two). **(10)**

(1) Derive the Schrodinger's equation for free particle in one dimension and generalize it into three dimension .

(2) Explain the conservation of probability and expectation values.

(3) Explain particle in a one dimensional potential well of finite depth.

4(b) Answer the following question (any one). **(4)**

(1) Prove that : Any two normalized wave functions $\boldsymbol{\Psi_m(x)}$ and $\boldsymbol{\Psi_n(x)}$ corresponding to two different eigen values $\mathbf{E_m}$ and $\mathbf{E_n}$ are orthogonal.

i.e. $$\int_{-\infty}^{+\infty} \psi_m^* \psi_n \, dx = \delta_{mn} \equiv 0 \; ; \; m \neq n$$

(2) Derive one-dimensional time dependent Schrodinger equation for a free particle.

5(a) Answer the following question (any two). **(10)**

(1) Define : The Adjoint of an operator .
Prove that : (i) If A and B are the adjoint operator and C is a complex number then $(A + B)^{\dagger} = A^{\dagger} + B^{\dagger}$
(ii) $(C A)^{\dagger} = C * A^{\dagger}$
(iii) $(A^{\dagger})^{\dagger} = A$.

(2) Prove that momentum operator is self adjoint . Show that eigen values of self-adjoint operator are real .

(3) Derive the equation for the time evolution of the coherent state .

5(b) Answer the following question (any one). **(4)**

(1) Explain the two fundamental postulates of wave mechanics related to representation of states .

(2) Prove that : (i) $\mathbf{[\, x , P_x \,] = [\, y , P_y] = [\, z , P_z] = i \hbar}$
(ii) $\mathbf{[\, y , P_x] = 0}$

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